Capturing the Visitor Profile for a Personalized Mobile Museum Experience: an Indirect Approach

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ABSTRACT

An increasing number of museums and cultural institutions around the world use personalized, mostly mobile, museum guides to enhance visitor experiences. However since a typical museum visit may last a few minutes and visitors might only visit once, the personalization processes need to be quick and efficient, ensuring the engagement of the visitor. In this paper we investigate the use of indirect profiling methods through a visitor quiz, in order to provide the visitor with specific museum content. Building on our experience of a first study aimed at the design, implementation and user testing of a short quiz version at the Acropolis Museum, a second parallel study was devised. This paper introduces this research, which collected and analyzed data from two environments: the Acropolis Museum and social media (i.e. Facebook). Key profiling issues are identified, results are presented, and guidelines towards a generalized approach for the profiling needs of cultural institutions are discussed.

CCS Concepts

• Human-Centered computing→ HCI design and evaluation→user models and user studies

Keywords

Personalization, user modeling, profiling, mobile systems

1. PERSONALIZED APPLICATIONS

Personalized museum applications are becoming increasingly popular [1] as a means to approach the vast amounts of available digital information. Especially with regards to museums and museum learning, personalized applications can be a valuable tool [2], since they can adapt to a diverse audience's needs. An increasing number of museums and cultural institutions around the world use personalized, mostly mobile, museum guides to enhance visitors' experiences [3], attract new visitors [4], and address the needs of a diverse audience [5].

In addition, personalized applications in cultural heritage seem to be preferred by the visitors [6]. There are adaptive applications for different target groups in museums [7]. In addition, there is a wide range of mobile and space sensitive devices that provide personalized content [8]. Recent developments include the use of social media in personalization processes and popular media, like YouTube and Pinterest [9], Instagram [10], Twitter [11] and Facebook [12], which are used to create and evaluate personalized cultural heritage content. Even social media games have been adopted to extract user profiles for future museum visits [13], and visitors have been asked to create recommendations for their friends and loved ones [14]. Ardisonno et al. [15] provide a detailed survey of the field of personalized applications in cultural heritage.

Personalization is based on the assumption that the application can understand the user's needs, to provide the most relevant and interesting context, and its success relies greatly on the successful elicitation of the user profile. In a typical museum visit, in some cases carried out in the context of a city site-seeing tour, visitors' time is limited. It may last as little as a few minutes [16], and visitors might only visit the cultural site once. In this context, applying a user profiling method that will engage the user into providing the relevant profiling information may in fact decide the success or failure of the museum experience.

Thus, visitor-profiling processes need to be quick and efficient; but the main question is how to start. The problem of "cold start" is well recognized in the literature, and still a state-of-the-art topic. Indicatively, [17] used various heuristic techniques and algorithms to tackle the problem. In another approach, [18] used reading experts and probability-based algorithms to enhance a personalized news recommendation system. The user profile initialization is also an important aspect for personalized museum applications and a particularly challenging problem to tackle [19]. Thus, in the field of cultural heritage there have also been efforts to minimize the problems of personalization initialization with the use of 'personas' [20].

The different approaches to the "cold start" problem can be distinguished as either explicit, meaning that the visitor is aware of the process, or implicit, meaning that the visitor is not aware of the process (e.g. [21]). Explicit approaches can be split into two categories: direct and indirect. Asking directly the user about her specific museum interests and where she would like to go next is an example of a direct approach; so is asking the visitor to set her own profile through questionnaires. However, visitors seem to not be so keen on direct interrogation or form-filling activities [1]. Indirect explicit approaches also ask the user questions, but these are only indirectly related to the museum content [22]. Moreover, if carefully designed, they may inject an element of excitement, and therefore increase positive involvement in the profiling process.

Implicit approaches include methods like the one described in [22], where visitors were asked to customize avatars, hypothesizing that this process might reflect individual traits. On the other hand, the PIL (Personal experience with active cultural heritage – IsraeL) project uses information previously gathered from the user's interaction with a webpage, collecting information prior to the visit [19]. Finally, visitors' pattern of movement in the museum is another way to gather valuable information, since research shows a correlation between physical movement and cognitive needs [21].

In this paper, we investigate the use of indirect profiling methods in museum-personalized visits, in order to adapt the museum content according to the different visitor profiles. Research was conducted in the context of the EU-funded project (Project name removed for anonymity purposes), which developed a system aimed at enriching museum visiting through adaptive personalized interactive storytelling. The application contained several levels of personalization, from initial selection of the most appropriate story given visitors' interests, visiting style and available time, to real-time adaptation of the initial plot depending on visitors' actions in relation to exhibits, the story or the museum space. A short questionnaire or quiz, the (project name removed) Visitor Questionnaire (CVQ), was designed to initially identify the users' characteristics, preferences, and visiting context, as a basis for early personalization and subsequent adaptation. Yet, in order to enhance enjoyment and surprise, it was designed as part of the visit. Since the quiz is the first step in a personalized museum experience, its design and implementation should be tailored not only to the needs of a particular museum, but also to particular mobile storytelling experiences. Moreover, it is also part of the authoring process and therefore museum professionals should be able to create and update it.

The research presented in this paper was conducted at the Acropolis Museum of Athens, as part of a multi-phased investigation about personalization. The design of the CVQ started with an initial pilot study, described briefly below. Based on its results, two stories were authored, the application was implemented, and its overall performance was tested during the summative evaluation of the (project name removed) experience. A parallel study, which is the focus of this paper, explored further some of the previous results, by assessing two different, albeit complementary, approaches to quiz design: the first involved visitors' various art preferences in the cultural setting; the second was conducted through on-line quizzes distributed in social media. Our approach also adopted elements from the available past research in the area of implicit user profiling methods. Although the ultimate goal of the present study was the design of an effective profile initialization method for (project name removed), its conclusions can be applied to any museum mobile application employing personalization.

2. THE CVQ PILOT STUDY

We initially explored whether certain film and reading preferences could be indirectly linked to museum preferences, and in particular to specific stories. Stories, in this setting, are coherent narrations by fictional characters (e.g the mythical hero Theseus or a woman from Archaic Athens), which evolve around the exhibits. Two stories with specifically designed characteristics were created, and 10 people were asked to choose one of the two. Participants were also asked to specify their reading preferences (possible answers: literature/fiction, non-fiction, newspapers/magazines, comics/graphic novels) and their film/TV preferences (possible answers: science/technology programs, history documentaries, cooking, drama/comedy, sci-fi/ fantasy). The motivation behind these choices given to the participants is the fact that preferences like these (i.e. film and book preferences), are usually indicated by users in different social media. If our hypotheses were supported these would imply that social media user profiles could be directly linked to specific museum narrations (i.e. specific style of language). All participants were selected amongst both staff and graduate students of the Department of Informatics and Telecommunications of the University of Athens (Greece). 5 were male and 5 were female, with ages ranging from 20 to 39 years old. The responses to each question were given weights, adding up to a total relevance score for each user, which was then compared to the score assigned to each of the two stories. The results of this initial study indicated that specific film and reading preferences could be indeed linked to a certain story.

Following this short pilot study, the quiz application was designed and implemented. The CVQ was conceived as a configurable web application that enables visitors to reveal their preferences to the system, by answering a series of multiple-choice questions. The system is generic and can be used to implement any quiz, provided it uses the constructs supported (single choice, multiple choice and ranking questions) and any of the presentation formats supported (textual, visual, single/multiple column layout, etc.). It also supports a flexible model for mapping the answers to personalization variables. The quiz logic is based on an abstract quiz description, which is accompanied by assets that control the presentation, namely images, style sheets and templates. The full specification of how answers map to variables is expressed through an XML representation. The application is able to present the quiz, collect the results, and generate the visitor variables necessary for content personalization. It is built with an industry standard approach, using JAVE2EE technology, and implemented in JBOSS Java Beans and the Google Web Toolkit framework (http://www.gwtproject.org/). This allows the quiz to be created, edited, and adjusted dynamically, according to each museum needs and delivery platforms (e.g., web, tablet, smartphone). An overview of the personalization approach implemented in the (project name removed) system may be found in (removed for anonymity purposes).

The CVQ has two versions, one for adults and one for children. Both include two initial questions about age and gender. Subsequently, adults are offered the possibility to choose their favorite film type (superhero, romantic, war, myths, or animal film) and newspaper section ("politics and economy", "sports", "society and everyday life", or "comics"). The children's version asks about their preferred activities (choice from: "horse riding", "karate", "basketball", and "cooking"), and preferred kind of character (choice from: "Gods, warriors and heroes", "Everyday people", "Men of sports", and "Animals and monsters"). The quiz can be found at http://chess.madgik.di.uoa.gr:10005/cvs-acropolis/.

In parallel, two new stories matching visitors' traits and film/reading preferences were created through an iterative co-authoring process involving several specialists. The stories were based on the characteristics of 2 personas (there were 6 personas in total) that had been previously identified at the Acropolis museum [20]:

Theseus: "Theseus, the famous hero of Athens needs your help to build an army after exiting the Cretan labyrinth! Join him in an exciting adventure to get all sorts of human, animal and divine aides!"

Melesso: "Melesso, a noble Athenian woman, talks about her life in the city of Athens. She has many things to say! Join her journey of memories, choose the ones you want her to share with you, and learn about the historical events that affected her life."

In the story of Theseus, the visitor interacts mostly with its main character in a quest to find different potential fighters that are represented by the exhibits (e.g. statues of Hercules or the Rampin horse rider). The visitor must decide whether a particular fighter should join the fictional team in aiding Theseus. In the process, the visitor "meets" other characters and hears stories about Greek mythology, war, or sports.

The second story is different on several levels. Melesso is the sole character and describes life in ancient Athens. The story is less explorative, but much longer, with many branches and opportunities for personalization. It covers different topics, including love and marriage, women's life, the Acropolis temples, religion, historical events, etc.

The CVQ was tested with these two stories during a two-day summative usability and user experience evaluation at the Acropolis Museum. 28 visitors (16 male and 12 female), all of ethnic Greek background, with ages ranging from 11 to 45+, participated in the evaluation. The recruitment was mainly based on demographic information (such as gender, age or profession). At the beginning of the experience, a small tutorial of the (project name removed) application was given. Then, users filled in the CVQ and one of the two stories was suggested to them, based on their elicited profile. To assess the CVQ performance on the initial story suggestion phase, a short pre-visit interview was conducted. Firstly, users were given a short description of the two stories (summarizing the plot and the main topics covered) and they were asked to rate them in a five-point Likert scale. Participants were only given the short version of the stories, due to the fact that the full duration of the stories was more than 30 minutes each. Secondly, they were asked to justify their ratings, explaining what they liked or/and disliked in each story description. In addition, after the visit the participants discussed in depth with the researchers about exhibits and story elements and the results were combined with the pretest results to form the ground truth of the study.

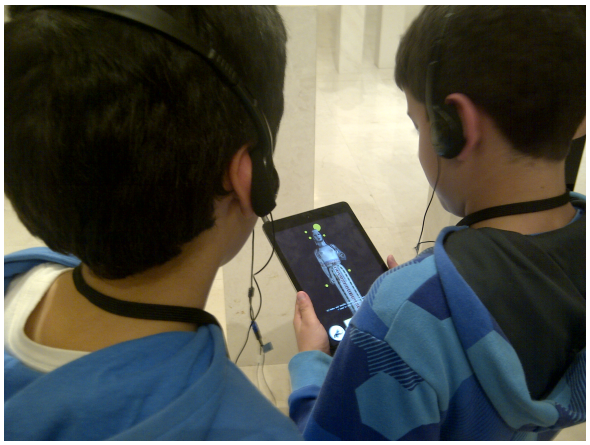

Fig. 1 Evaluation of mobile experience with visitors at the Acropolis museum

User input and ratings were analyzed and they served as "ground truth" for evaluating CVQ performance for the initial story suggestion phase. The analysis was conducted on 24 viable cases; 3 users did not perform the CVQ due to time constraints and 1 user could not choose between stories. The results show that the system matched the user's manual selection of story, in 75% of cases (18 right and 6 wrong). However, the qualitative analysis of user input revealed that in many cases, users did not have a strong or even clear preference over one of the two stories; two users actually remarked that they made an impulsive selection, driven mainly by their familiarity with the narrating characters. Focusing on the 10 cases where a strong preference was expressed, both in terms of rating (i.e. having distance greater than one) but also during the discussion afterwards, we observed that some visitor decisions were solely based on their likes, and especially dislikes on particular topics, others were based exclusively on their preference over the game-flavor of the Theseus story (independent of the topics covered), and the rest of them were influenced by both of these factors. Over this set of 10 cases, the system's performance reached 90% (9 right and 1 wrong suggestions), indicating that the CVQ has been successfully employed so as to measure, prioritize and combine both of the main factors driving visitor decisions (i.e. topics covered and type of story).

Once the pre-visit interview was completed, a story was assigned to each visitor by the evaluators (the assignment was pre-determined so as to have a balanced set of story experiences) and the visit started. The elicited profile (based on the visitor's CVS answers) is used by the CHESS system in order to make personalized suggestions and decisions on how the story will evolve. Throughout the visit, the initial profile is continuously updated based on visitor actions, using implicit feedback techniques [23].

After the experience, the visitors were interviewed again, and asked to assess whether the story assigned to them had actually evolved according to their likings or not. To answer this question, a detailed post-visit interview was conducted; the complete story graphs were presented to the visitors along with all the available story options and corresponding system decision at each point, and visitors rated the system's decisions in a 3 Likert scale (right decision, neutral, wrong decision). Overall, the (project name removed) system reached approximately 89% of right decisions during the visits performed in the two-day evaluation in the Acropolis Museum, thus tailoring them so as to better match the visitors' profiles.

3. EXLPORING EXPLICIT INDIRECT PROFILING FURTHER: THE PARALLEL STUDY

Following the positive results about film and reading preferences obtained from the pilot study, later confirmed in the summative evaluation, new potential indicators of museum preferences were explored through a parallel study. In particular, the research team investigated how different visitor features and choices might correlate with different elements of exhibition design that can be personalized. The study was divided in two phases, during which information was collected from two different environments: the Acropolis Museum and social media.

3.1 In-situ study at the acropolis Museum

The purpose of the study at the Acropolis Museum was to determine whether visitors' artistic choices might relate to their visiting preferences. A questionnaire was administered in the form of an interview (in English, Greek or Spanish) to 100 visitors (37 male and 63 female). From them, 12 were under 18 years of age, 42 were between 19 and 35, 34 were between 36 and 55, and 12 were above 56. Visitors were approached after their visit, either as

they entered the museum café or on their way out of the museum. The questionnaire can be found at http://www.chessexperience.eu/v2/index.php?option=com_phocadownload&view=category&id=15.

The first questions were demographic (age, gender, nationality, and whether they had visited the Acropolis Museum before). Although the museum experts did not consider gender as a defining factor in the appreciation of museum content, the design team reckoned that gender might account for some aspects of the user experience [24]. The question about previous visits was relevant because the system could suggest different activities for returning visitors.

The next set of questions was related to art preferences, including favorite type of music and artistic style. Music preferences were collected through an open-ended question to allow participants describe their exact predilections. For artistic style, three different portraits of Mona Lisa were presented (images not used here for copyright purposes, the links are given instead):

1. the original painting, representing a more classical taste
2. a pixelated version (Cubea Lisa by David Grebeling, http://www.ciphermysteries.com/mona-lisa-but-made-of), representing modern art inclinations
3. a Lego version, representing a fondness for Pop Art (Mona Lego by Marco Pece, http://www.ciphermysteries.com/mona-lisa-but-made-of).

Similarly, three paintings of the Acropolis of Athens, all from famous Greek artists, were also presented:

1. a realistic representation of the monument, corresponding to classic art preferences ("The Parthenon" by Louis Dupre, 1810-1837, http://www.wikigallery.org/wiki/painting_216639/(after)-Dupre,-Louis/The-Parthenon-Athens)
2. a more abstract approach, corresponding to modern art preferences ("Acropolis" by Agenor Asteriadis, 1897-1977, http://lesxianagnosisbiblioudegas.blogspot.no/2013/11/1898-1977.html)
3. one corresponding to romantic style art preferences ("Acropolis" by Lykourgos Kogevinas, http://www.nationalgallery.gr/site/content.php?sel=247&artwork_id=71534).

The next question dealt with language style in texts. Three different fragments describing the same museum object (a three-bodied monster) were used: a more formal text; a more personal text, narrated in first person; and a more playful text, narrated in first person and including prompts to the user (Table 1). As the narrative style was considered by museum authors a primary personalization feature, this question was included in order to see possible connections to other variables (e.g. gender, age, etc.).

The next question asked visitors what activities they would like to do in the museum. Such activities included listening to stories, playing games, creating museum inspired art, commenting on exhibitions, and engaging in a dialogue with other visitors.

The next set of questions (3 questions) was related to visitors' cognitive preferences and features. Some of these questions were inspired from the Myers-Briggs Type Indicator for Cognitive Style [25] to assess extraversion/introversion. Extraversion/Introversion, since extraversion/introversion is related to user control [21]. Control is an important aspect of personalized technologies, but our pilot tests of the questionnaire had shown that: 1) a direct question was not always understood by participants; and 2) control preferences seems to be influenced by factors depending on both the visitor (e.g. personality, cognitive style) and the situation (e.g. tiredness, desired information depth). Consequently, two kinds of questions were included. The first kind asked visitors about their level of introversion/extraversion. In this case, low user control corresponded to the answers "I prefer to do one thing at a time" or "I want clear instructions", while answers like "I prefer to do lots of things at once" or "I prefer to figure things out" would correspond to the fully interactive option with high user control. The second kind of questions, linked to the situation, asked about visitors' general state ("Today I feel tired" / "Today I feel energetic") and about the required depth of information ("Today I want to get a general feeling of the place", "Today I am interested in facts").

On the other hand, a personalized museum application should also consider the visitors' location and path. Past research has identified and classified different kinds of visiting patterns. According to Véron and Levasseur [26], there are four "visiting styles", which can be described by means of animal metaphors (ant, fish, butterfly and grasshopper). Given that previous studies [21] have shown that visiting style self-reports can provide valid information, one multiple-choice question asked visitors to describe their movement in the museum, in order to capture their visiting style.

Fig. 2. A researcher with visitors during the study at the Acropolis Museum

Finally, a question related to visitors' interest in the museum topics was also included. The topics presented were: everyday life; mythology; sports; society and politics; history and Architecture of the Acropolis; and animals. All these themes corresponded to material developed by the museum's curators and educators for the permanent exhibition.

3.2 Study via Social Media

The second phase of the parallel study on indirect profiling intended to collect additional data from the general public using social media. The questionnaire was distributed among the researchers' social network (asking friends to share with their friends). This was done independently of a museum visit, since we only wanted to see if art preferences in general correlated with specific preferences in museum content. An online survey was prepared and distributed on Facebook. However, it did not use the same material, except for one question. The reason was to minimize possible bias due to user familiarity with particular objects, as for example, it seemed that most visitors interviewed at the Acropolis Museum chose the original Mona Lisa picture

possibly because of its artistic importance, instead of taking into account the general style. Hence, it was decided that in this new study more neutral stimuli, avoiding famous art objects, would be used.

The online questionnaire (available at http://chess.madgik.di.uoa.gr:8082/cvs-exp/) gathered information about the following variables: gender; age; music preferences (pop-rock, classical-jazz, ethnic-folk) and art preferences. For art preferences three images of tulips were used:

- one for classic art preferences ("Tulips IV" by Anja Slijkhuis, http://www.globalartnet.org/images/tulips-iv);
- one for abstract art preferences (Step 1 image from http://www.dragoart.com/tuts/3924/1/1/how-to-draw-tulips.htm);
- one for pop art preferences (Final Step from http://www.dragoart.com/tuts/3924/1/1/how-to-draw-tulips.htm).

In addition, the design preferences of users were also recorded and three images of armchairs were used:

- the first represented classic design (Victor Armchair, http://yuarmcha.com/green-arm-chairs/);
- the second represented modern design (http://i.telegraph.co.uk/multimedia/archive/01666/p_habitat-chair_1666734i.jpg);
- the third represented pop art design (Proust's Geometrica Chair, http://cappellini.it/en/products/sofas-and-armchairs/proust-geometrica).

Book preferences were also recorded (3 book summaries without the title: Dostoyevsky's "Crime and Punishment", Larsson's "The Girl with the Dragon Tattoo", and Robin's "Still Life with Woodpecker") (Table 2) together with language stylistic preferences and label length. Over a period of 2 months 155 valid questionnaires were collected and analyzed.

Table 1 Three-bodied monster descrptions

Formal	**First person narration**	**Informal using questions**
The Three-Bodied Monster is a composite creature consisting of three winged male figures conjoined at the waist with intertwining snaky tails. The Three-bodied Monster in the Acropolis museum is a unicum: it is the only representation of this kind that we have in the Greek world. We don't know who really the Three-bodied monster is. He is also called 'Bluebeard' because on each head, the beard was painted with blue. The color was more intense when the sculpture came to light during the excavations in 1888.	Don't be fooled by his wry smiles; he's a proper daemon. Some call him Bluebeard because his beards were painted a bright blue, back in the ancient times. You should have seen him when he was unearthed in 1888; the blue was more intense then. We're not quite sure who he is, but no matter who he is, he's one of a kind. It's what archaeologists call a unicum, meaning it is the only representation of its kind in the Greek world.	Monsters here, monsters there, monsters everywhere! Hey, look to your right, there's another horrible monster, a daemon with three heads! Have you spotted it? Come on, it's staring you in the face– all three faces! This scary monster was called Bluebeard because his beards were painted a bright blue. Can you see the traces of color?

Table 2 Available book choice

Classic book preference – *Crime and Punishment*	**Contemporary book preference** - *The Girl with the Dragon Tattoo*	**Pop book preference** - *Still Life with Woodpecker*
Saint Petersburg, year of salvation 1866. A double murder is committed. Victims: an old female usurer and her defenseless sister. Perpetrator: Raskolnikof, an ex-student consumed by the idea that he is super-human and is entitled to commit murder for the benefit of humanity... The action brings re-action and the crime causes punishment. What will be his punishment? And where will it come from?	Harriet Vanier disappeared thirty six years ago during a summer festival at the Swedish resort Hendeby. There was a police investigation, but there was never any trace of the sixteen year old girl. Did she run away? Was she abducted? Or murdered? Nobody knows. – the case is closed, everybody has forgotten the details. Everybody, except her uncle, Henrik Vanier, an elderly industrialist who has made it a life objective to solve the mystery before he dies.	It is a kind of love story taking place in a Camel cigarette pack. It reveals the goal of the moon, describes the difference between criminals and outlaws, examines the conflict between an engaged socialist and a romantic individualist, and paints the portrait of a modern society with rich Arabs, exiled kings and pregnant cheerleaders. Lastly, it discusses the mystery of the pyramids...

4. RESULTS

4.1 Results from the Acropolis Museum

The results of the two studies were statistically analyzed with SPSS. Since all data were categorical, Chi Square tests for independence of attributes were performed. For the analysis of expected low frequencies (e.g. for questions with several possible answers), Likelihood Ratio tests were used. Finally, Bonferroni corrections were also applied.

Comparisons from the study at the Acropolis Museum that provided statistically significant correlations are summarized here. Different personal characteristics and preferences (e.g. age, mood, art predilections) were compared to the different important personalization variables (e.g. narration style, museum activities, museum themes). The main goal was to find indirect ways to link stories to different variables.

We will start with the exhibition design variables. Regarding narration style, it was found that it significantly correlates with:

Age [χ^2 (6, N=99)= Pearson .034, p<.05], since older visitors preferred the formal description of the Three-bodied monster.

Music choices [χ^2 (4, N=99)= Likelihood Ration .05, p=.05], since people who liked classical music also chose the formal description of the Three-bodied monster.

Game choices [χ^2 (2, N=99) Pearson = .019, p <.05], since people who chose the formal descriptions of the Three-bodied monster also stated they were not interested in participating in museum games, whereas people who chose the least formal text, stated they would like to play games like museum treasure hunting or role playing games.

A second set of results concerns museum activities that visitors were likely to engage with, which significantly correlate with:

Art preferences [χ^2 (2, N=99) Pearson = .049, p <.05]. Although not many visitors chose to play mini games in the museum, it seems that this is especially the case of people who chose the classic Mona Lisa. This is an important finding, since simply by asking visitors' art preferences in an initial quiz, applications could adapt their activities accordingly.

Museum themes [χ^2(1, N=99) Pearson = .041, p <.05]. People interested in art activities in the museum chose the mythology theme. The mutual dependence between preferred activities and themes may constitute a powerful instrument for a successful adaptive application, since preferred topics of interest can be detected early in the visit.

Mood [χ^2(2, N=99) Pearson = .048, p <.05]. Again, it was not surprising to find that people feeling energetic and relaxed were more likely to engage in exploratory museum games than people who report feeling tired. Consequently, asking visitors' mood should be useful to define the adaptive content, especially regarding paths and activities.

Visiting style [χ^2 (3, N=99) Pearson = .05, p =.05]. "Butterfly" visitors were not very likely to write any museum related comments, compared to other visiting styles, and especially to "fish" visitors, who seemed to like the option of writing comments. An application that could record visitors' moving patterns and extract their visiting style, could suggest different museum activities for different styles, adapting to visitors' preferences.

A third set of observations regarded the museum themes, which correlated with:

Gender [χ^2(1, N=99) Pearson = .039, p <.05]. Women were found to like everyday life in Ancient Greece and in particular, aspects like clothing, body care, etc. A quiz asking visitors to provide gender information could allow effective adaptation.

Place of origin [χ^2(6, N=99) Pearson = .039, p <.05]. Greeks, other Mediterranean and Northern Europeans were mostly interested in mythology. On the contrary, visitors from Oceania (Australia and New Zealand) were not very interested in it. Knowing visitors' place of origin may be important in determining what information about exhibits will be presented. However, the present study used a limited sample (Greece=40, North America=20, Oceania=10, Other Mediterranean =8, North Europe = 11, South America = 5, Other =5), implying that all the statistical analysis can only show possible indications, worth studying further though in future works.

Age [χ^2(3, N=99) Pearson = .002, p <.05]. Younger visitors were more interested in mythology than older visitors. Again, visitors' age can give important information about different thematic preferences and should definitely be included as a personalization instrument in adaptive applications.

Other museum themes [χ^2(1, N=99) Pearson = .044, p <.05; χ^2(1, N=99) Pearson = .039, p <.05]. Visitors who did not like mini games, did not like themes about sports in Ancient Greece either. On the other hand, visitors who were not interested in sports were not interested in animals in ancient Athens either. It seems that there was a correlation between different themes. This is a useful information for adaptive applications, which may extrapolate information obtained with the quiz to avoid asking too many questions and at the same time allow more effective adaptivity.

Returning visitors [χ^2(1, N=99) Pearson = .017, p <.05]. People who had come to the museum before seemed to be more interested in society and politics than people who visited for the first time. It seems plausible that having previously been in contact with the exhibits' basic information, visitors wanted to explore other aspects in their returning visit. Thus, a profiling quiz should take this piece of data into account, so that the application presents basic or "alternative" knowledge.

The analyses also provided relevant results regarding visitor personal features and choices. The first set of results concerns visiting style, which significantly correlated with:

Place of origin [χ^2 (18, N=99) Pearson = .013, p <.05]. This correlation has been evidenced by other studies (Antoniou and Lepouras 2010). Hence, it was decided to pursue further the investigation, by dividing the participants into 7 main geographical areas. The results showed that Greeks followed mostly an "ant" visiting style, with "fish" in second position. It seems that Greeks had a clear preference for linearity of movement, whereas northern European seemed to follow non-linear patterns in their movement ("butterfly" visiting style). It is interesting to note that no Greek showed "grasshopper" behavior. Although the representability of the sample requires further research, the current and other studies seem to point at a strong connection between visitor's place of origin and museum movement. If this is the case, then future museum applications should take into account visitors' origin and adapt accordingly.

Cognitive traits [χ^2 (3, N=99) Pearson = .019, p <.05]. Previous studies (Antoniou and Lepouras 2010) have also indicated that

visiting style correlates with cognitive style. In our case, the most extravert visitors showed a "fish" behavior; while the most introvert visitors showed, by far, an "ant" behavior. As above, the system's awareness of visitors' personality would allow suggesting different visiting approaches (e.g. more collaborative or individual). At this point it is important to note that cognitive traits in this study were assessed with only 3 questions from the MBTI, implying that extraversion and introversion here are rather indications of extraverted/introverted behavior and not definite personality analysis.

Mood [χ^2 (6, N=99) Likelihood Ratio .02, p <.05]. More active visitors were more likely to show "ant" behavior. In addition, active visitors did not show any "grasshopper" behavior. Understandably, tired visitors do not have the stamina to see each and every exhibit on detail, and consequently adopt different visiting styles. Therefore, a quiz question asking visitors about their mood upon arrival provides valuable information about their potential moving patterns, thus allowing for an adaptive system to suggest the most suitable museum paths.

The second set of results regards other art preferences, which correlated with:

Art preferences [χ^2 (4, N=99) Pearson = .008, p <.05]. Most people who chose the original Mona Lisa also chose the classic postcard of the Acropolis, which indicates a consistency in people's artistic preferences. This is a useful information for an adaptive application, which may extrapolate information obtained with the quiz to avoid asking too many questions and at the same time allow more effective adaptivity.

Returning visitors [χ^2 (2, N=99) Pearson = .029, p <.05]. People who chose the romantic style postcard had been in the museum before, while people who chose the classic postcard had not. It may seem that first- timers were interested in a realistic version of the monument, whereas returning visitors, having seen the monument before, were more interested in alternative interpretations of the site. This is consistent with the correlation between returning visits and museum themes: if indeed returning visitors allow space for other interpretations, it could be used to adapt the quantity and quality of information in cultural heritage personalized applications.

Cognitive traits [χ^2 (2, N=99) Pearson = .001, p <.05]. This is an interesting finding, since this very high correlation indicates that people who chose the classic postcard were mostly introverts, while people who chose the romantic one were mostly extraverts. As cognitive traits are linked to both visiting style (see above) and art preferences, knowing the latter might provide valuable information to suggest different paths and visiting approaches (e.g. collaborative activities). The same results are observed when all extraversion questions were combined [χ^2 (2, N=99) Pearson = .034, p <.05], which validates the findings.

The last results of the study conducted in situ at the Acropolis Museum concern visitors' mood, which seems to be heavily affected by age [χ^2(6, N=99) Pearson = .017, p <.05]. Not surprisingly, the older visitors are, the more tired they report. Since visitors' mood also affected their visiting style (see above), personalized applications should ask for the age and adapt the visit to this variable (e.g. tend to propose more relaxed, "fish"-like paths to elder people).

4.2 Results from Social media

The second part of the parallel study analyzed data gathered from Facebook. There were only three significant findings, although only one can be applied to the design of museum personalized applications. Firstly, it was found that age and gender highly correlated, which implies a biased sample due to its limited size (N=155). Secondly, there was a correlation between gender and furniture style preferences [χ^2 (2, N=155)< .005 and Likelihood Ratio (2, N=155) < .005]. It seems that males preferred modern furniture compared to other styles like classic or pop. Thirdly, and most interesting for us, gender highly correlated with text style preferences. In particular, women seem more open to alternative text styles, like personal and informal, whereas men seem to prefer standard and formal text styles [χ^2 (2, N=155) <.05 and Likelihood Ratio (2, N=155) < .05]. For the design of museum adaptive technologies, this finding implies that women could easily accept a more playful and informal text or narration style.

5. DISCUSSION

Profiling for museum application personalization is a very challenging task. Visitors are not only unique personalities with specific goals and preferences; they are also affected by particular circumstances, such as mood or available time for the visit. Any profile initialization method has to take into account all these factors in order to be truly effective and usable in a museum context. It needs also to be based on an appealing and non-intrusive design, and to be brief and interesting.

The study presented in this paper produced useful results regarding quiz design on several aspects of the museum experience. Correlations between exhibition elements (topics, activities, and text style), visitor choices (in art, style, and music) and personal traits (age, gender, origin, personality, mood, returning visit and visiting style) were found. The personalization approach followed in the present work combines situational dependent personal traits (like mood, visiting style, etc) with situation independent traits (like extraversion, age, gender) and exhibition elements, showing specific relations among all these.

Asking about gender and age may be also useful for the personalization of topics and narrative style. Women seem to prefer empathic approaches like information on people's lives and fantasy tales. Equally, visitors' country of origin has a role in the topics they are interested in. Museum professionals should take into account these different cultural perspectives, and design contents that are meaningful to different visitors or that help them better understand the museum's own cultural context.

Applications also should take into account whether visitors have already visited the museum. In this case, the system should propose topics other than the basic, descriptive information about exhibits. It seems logical that visitors who have already been at the museum will have different museum interests than new-comers. Moreover, it is worth mentioning here that returning visitors also wanted to go beyond the realistic representation of the monument (unlike new-comers) and move towards less realistic representations that emphasize on emotions, as romantic art does. It might be the case that the first time visitors view a monument, they are engaged in rational cognitive processes in order to understand the characteristics of the place, and after they have done that, they are able to engage in more affective processes. In any case, this is a very interesting finding, which definitely requires further psychological research.

Visitors' mood is also a good indicator for personalization, since it influences the kind of activities visitors would like to engage with. The more energetic the visitor feels, the more he/she is willing to undertake explorative activities and exchange with others. Finally, different movement patterns (visiting style) appeared to be related with different museum activities. The specific results obtained in this study are difficult to interpret, but may be explained by the third level of correlation, where associations between personal characteristics have been found. In particular, visiting style is related to country of origin, personality, and mood. It is therefore possible that the wish or not to live written comments respectively by "fish" and "butterfly" visitors is related to their cultural background and/or their level of extroversion/introversion. What seems clear is that introverts tend to follow "ant" patterns, while extraverts move like "fishes" (who expressed their wish to leave comments). On the other hand, visitors who feel energetic tend to visit the exhibition with more detail ("ant" style) than those who are tired. Considering that it is difficult for visitors to directly reflect and report on their movement patterns in the museum, having indirect ways to estimate their visiting style might be very helpful.

In addition, Art preferences (including painting and music) are powerful instruments for indirect profiling and personalization, since they can be related to several elements: narrative style (music), preferred activities (painting), and topics of interest (style). The general conclusion to be drawn for personalization is that visitors who like "classical" art, prefer more "traditional" museum experiences.

Certain correlations can also allow extrapolations, and therefore the quiz can be shorter (by using questions that are related to several variables) and more engaging (by using "catchy" instead of challenging or sensitive questions). For example, visiting style (see above) or personality. Adapting psychometric questionnaires to ask visitors about their character may be tricky. Art preferences come in handy again, as the results of this study support their direct correlation to personality types. In our case, classic artistic preferences imply higher chances of introversion, while more romantic styles imply higher changes of extroversion.

A similar kind of extrapolation could be performed with mood. Visitors' disposition influenced the activities they would like to undertake at the museum, and is linked to both visiting style (see above) and age. It would be logical to link visiting style, activities and age through mood and assume that the older the visitor, the lighter the path and activities he/she will like to follow.

Finally, there are correlations between visitor choices and between museum features. In the first case, different kinds of artistic styles or presentation formats correlate between them (e.g. "classical" Mona Lisa with "classical" Acropolis). In the second case, independent museum themes that were conceptually linked were also statistically linked (e.g. sports and animals). Moreover, specific themes were also linked with specific activities (e.g. art and mythology). This intellectual consistency may prove very helpful to personalize more in depth information and museum activities from an initial general question about interests.

It is interesting to note here that during the evaluation process many participants were interested in finding out what their answers might mean for their personality. It seemed that many viewed this quiz as a pop psychology test and were interested in the results. In addition, in the Melesso story there was one such quiz, as part of the activities associated with that character, called ""What role would you have in the ancient Athens Panathenaea procession?". It was very interesting to see how involved participants became, since information as given back to the users concerning her personality. Thus, creating quizzes that give (personality) information back to the user are important participation motivators and our future work will explore this aspect further.

6. CONCLUSIONS

This paper presented a study related to indirect user profiling in a museum context. In order to investigate how different visitor characteristics and choices might correlate with different elements in a museum experience that can be personalized, quiz-like questionnaires were designed for the Acropolis Museum and administered both in situ and through social media.

Our experience confirms that there is a trade-off between using questions that can lead to concrete decisions on user preferences in a time efficient manner and making the quiz both an accurate profiling tool for authors and an interesting experience for visitors. If the aim is to transform the traditional museum visit to an appealing storytelling experience, the quiz needs to become an appropriate introduction to the experience; it must be short and intriguing, and attempt to record the user's profile in a subtle and non-intrusive manner. Our study seems to indicate that art preferences (i.e. film, visual arts, music) and other visitor characteristics (i.e. age, gender, mood, etc.) may be a powerful instrument for personalization. However, this is an exploratory study, which aims to provide preliminary results that open the way for further research in several directions.

Although our research design was tailored to the user profiles and the storytelling purposes of the Acropolis Museum, our findings can be extrapolated in different ways, depending on the particular goals of each museum. As an example, we provide two possible scenarios. In the first scenario, a museum would like to offer collaborative and/or gaming activities. In this case, age, mood, origin, preferred topics, and artistic preferences might be important factors to gather through a profiling application. In the second scenario, a museum would like to offer multiple stories of different themes (possibly based on different interpretations of the exhibits). In this case, it would be useful to collect information about visitors' gender, age, place of origin, artistic preferences, and whether it is or not their first visit.

In conclusion, a carefully designed visitor quiz can lead to effective personalization and consequently enhance the museum experience. Although asking direct questions could provide more accurate information, we observed that people find the indirect approach of a quiz interesting and intriguing. Based on our observations on participant motivators, our future work will focus on the actual quiz itself beyond the context of storytelling. We are planning to adopt a pop psychology approach in the quiz design, such as those that have become popular in social media (e.g. "What is your dream holiday place?" "Which famous character are you?"). We would then like to test this approach in a real museum setting, using the inferred user profile to offer different visit paths in the exhibition. In addition, marketing theory will be considered, especially related to hedonic consumption to study further demographic characteristics, like age, gender, cultural background and their relation to museum content (e.g. [27]).

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